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AN INVESTIGATION OF THE ADEQUACY
OF AIR FORCE REGULATIONS
GUIDING THE DEVELOPMENT AND
PROCUREMENT OF SOFTWARE USER MANUALS

THESIS

Amy M. Baines, Captain, USAF

AFTT/GLM/LSR/91S-2

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DEPARTMENT OF THE AIR FORCE

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Wright-Patterson Air Force Base, Ohio

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AN INVESTIGATION OF THE ADEQUACY OF AIR
FORCE REGULATIONS GUIDING THE DEVELOPMENT
AND PROCUREMENT OF SOFTWARE USER MANUALS

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Amy M. Baines, B.A.

Captain, USAF

September 1991

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Preface

The purpose of this study was to highlight the deficiency of guidance in the area of development and acquisition of Air Force software user manuals. As the Air Force continues to procure sophisticated weapon systems, it's imperative that it ensures the delivery of quality support documentation for use by Air Force personnel. Unfortunately, this problem was highlighted many years ago with no apparent effect on existing regulations. I hope this thesis, or spinoff articles derived from it, may stimulate the right people to correct this deficiency.

I would like to thank my thesis advisor, Major John Stibravy for his guidance and support. I would also like to thank Mr. Art Munguia for contributing his time as a reader to this thesis, and acting as a quality checker for information presented on the Air Force Technical Order system.

Amy M. Baines

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Abstract

Because of the high costs associated with software development, the Air Force has placed greater emphasis on controlling the cost and quality of software being procured. With this increased emphasis comes the need to ensure that the documentation procured to support that software is also quality controlled. This research evaluated the adequacy of current regulations by comparing the process for developing Air Force software manuals with the process for developing similar types of user manuals, both within and outside of, the Air Force.

The regulations guiding the development of Air Force software user manuals were first compared to the regulations guiding the development of Air Force Technical Orders. The requirements for software manuals were found to be unclear, dispersed through numerous regulations, and at times contradictory from one regulation to the next. The requirements for Technical Orders are centralized and clearly organized.

In comparing the Air Force regulations to the best commercial practices used by industry for developing software manuals, it was found that private companies have much more stringent requirements for ensuring quality documentation.

The research recommends a revision and consolidation of the regulations for software user manuals into a separate set of standards, similar to those for Technical Orders.

AN INVESTIGATION OF THE ADEQUACY OF AIR
FORCE REGULATIONS GUIDING THE DEVELOPMENT
AND PROCUREMENT OF SOFTWARE USER MANUALS

I. Introduction

General Issue

During the acquisition of new weapon systems, the Air Force procures technical documentation deemed necessary to operate and support those systems. Most types of technical documentation procured have specific format and content requirements specified in military specifications and standards. The appropriate specifications and standards are included in the acquisition contract, and thereby imposed upon the contractor for use in developing and delivering the documents.

The most important types of technical documents are user documents; these are intended for use by Air Force personnel on a regular basis to operate or maintain the new system. User documents are applicable to both hardware and software components of a system. With the increasing use of sophisticated computer programs in military weapon systems comes a greater requirement to ensure the adequacy of the documentation for operating and supporting those computer systems. In the last few years, the Air Force has placed greater emphasis on the quality of software being procured,

and has generated new regulations for stricter guidance and control of software development (16:1). It is important to ensure that the user documentation to support that software is also strictly controlled to provide quality documentation for Air Force personnel.

Background

Generally, when a new weapon system is procured, computer software must be developed that will be embedded within, and is peculiar to, that new system. There are many varieties of documents which can be procured to support computer software. Some documentation is procured to monitor the process of software development. This type of documentation is used by acquisition officials to control the contractor's schedule and development strategy for software. Another type of software documentation, perhaps the most important type, is the documentation that is used to support software once it has been embedded in the computer system. This includes manuals used by Air Force personnel to operate and maintain the software after the system is in the field.

In 1986, the Air Force revised and expanded its regulations on software development and acquisition, in an attempt to better regulate the process and thereby control costs, which can amount to a considerable portion of the total acquisition cost. Although some areas of the software acquisition process are now well documented and

comprehensive, the requirements and processes for software manual documentation, specifically user documents, are still dispersed and unclear.

Another type of user documentation that is common in the Air Force is Technical Orders (TOs) which pertain to the operation and maintenance of hardware components of a system. The development and procurement process for TOs is well documented and will be used as a basis for comparison with the development process of software user manuals. This is an appropriate comparison since both types of documents are developed for use by Air Force technicians in supporting new weapon systems.

Problem Statement

No determination has been made as to the extent of Air Force guidance on software user manual development, and the adequacy of that guidance for allowing acquisition officials to procure quality manuals.

Research Objective

The objective of this research is to determine the adequacy of current Air Force regulations for the development and acquisition of quality software manuals, and then identify possible changes or additions to those regulations which could improve their utility. This objective will be accomplished by answering the following research questions.

Research Questions

1. What are all the regulations guiding the acquisition and development of Air Force software user manuals?
2. How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?
3. How do the requirements for Air Force software user manuals compare to best commercial practices for developing similar manuals?
4. What improvements, if any, can be made to the current Air Force regulations guiding software user manual acquisition?

Scope and Limitations

For the purposes of this research, the phrase "software user manuals" will refer only to software manuals intended for use by Air Force personnel in operating or maintaining software. This research will examine all regulations, specifications, and standards applicable to the development and acquisition of Air Force software users manuals, in conjunction with new system acquisition; it will not review regulations for other DOD agencies. This assumes the computer software is embedded within and peculiar to the new system being acquired; therefore, this research also assumes the development of new manuals and will not cover the use of existing Commercial-Off-the-Shelf (COTS) manuals.

Finally, this research is exploratory in nature; no hypothesis will be tested. The intent is to evaluate the adequacy of Air Force regulations for software user manual development, and make recommendations based on that evaluation.

Benefits of the Research

The potential benefit of this research is to provide improved guidance for the development and acquisition of software user manuals. Stricter control of development, especially within the review process prior to acceptance, can increase the effectiveness of the manuals and thereby improve the ability of Air Force personnel to operate and maintain new software systems. These benefits could directly influence unit effectiveness and operating costs for a variety of systems already procured and those to be procured in the future.

Summary

Because of the high costs associated with software development, the Air Force has placed greater emphasis on controlling the cost and quality of software being procured. With this increased emphasis on software quality comes the need to ensure that the documentation procured to support that software is also quality controlled. This research will evaluate the adequacy of current regulations by comparing the process for developing software manuals with

the process for developing similar types of user manuals, both within and outside of, the Air Force.

Overview of the Thesis

Chapter I has provided a basic overview of the purpose and scope of this research effort. Chapter II will discuss the methodology that will be employed to answer the research questions, and analyze the results of the data gathered. Chapter III is a literature review that identifies all regulations guiding development of software user manuals; it also compares this guidance to Air Force guidance on the development of technical orders and to the best commercial practices employed by civilian companies for developing software type user manuals. The literature review will provide the basis for making recommendations for improvements to the current system of Air Force software user manual development. It also provides a basis for comparison between requirements the Air Force levies on its contractors to produce military products, and those levied by commercial companies upon themselves, for developing similar products.

Chapter IV will analyze the results of the literature review and provide specific answers to the investigative questions listed above. Chapter V will summarize the results of the literature review and analysis, and provide recommendations for changes to Air Force regulations guiding development of software user manuals.

II. Methodology

Introduction

This chapter will present the exact method of data collection that will be employed to answer the research questions put forth in Chapter I. A justification of the methods chosen will be provided, as well as the process for data analysis.

Research Methodology

As stated in Chapter 1, this research is exploratory. As such, all Investigative Questions (#1 through #4) will be answered by conducting an extensive literature review of Air Force regulations, military (or DOD) standards, and specifications, as well as commercial literature which deals with software manual or software documentation development. Investigative Question #1 (What are all the regulations guiding the acquisition and development of Air Force software user manuals?) will be answered by reviewing all regulations applicable to the development and procurement of Air Force software user manuals. Investigative Question #2 (How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?) will be answered by reviewing all regulations applicable to the development and procurement of Air Force TOs. Investigative Question #3 (How do the requirements for Air Force software user manuals compare to best commercial

practices for developing similar manuals?) will be answered by reviewing commercial literature that deals with writing technical documentation (in general), as well as developing and writing software documentation for software users. In most cases, this information will be contained in business related periodicals, technical journals, or organizational proceedings, such as International Technical Communication Conference Proceedings (29). The documentation required for this review was acquired from the Wright Research and Development Center Technical Library, Wright-Patterson AFB, Building # 22, the Air Force Institute of Technology (AFIT) Academic Library, Building #642, and the Wright State University Library, Wright State University, Dayton Ohio.

Investigative Question #4 (What improvements, if any, can be made to the current Air Force regulations guiding software user manual acquisition?) will be answered by comparing the requirements for Air Force software user manuals, Air Force TOs, and commercial software documentation in the areas of document content/format, quality reviews, and distribution/update control after publication.

Justification of Methodology

In his book, Business Research Methods, Emory devotes a chapter to the use of secondary data sources as a tool for research (19:135-152). Emory states that "...secondary data may be used as the sole basis for a research study"

(19:136). In discussing the various types of secondary sources, he states "Government publications are good sources of information in many topic areas" and "Periodicals are often the best single source of information for the business researcher...especially useful in providing the most current information" (19:144).

Validation of Method

In order to use secondary data with confidence, the researcher must ensure that the data used is pertinent, accurate, complete, and derives from a reliable source (19:152). In order to validate the data gathered for this research, Mr. Arthur Munguia, AFIT Associate Professor, School of Systems and Logistics and an expert in the acquisition of TOs, was a reader for this thesis.

Summary

This chapter has discussed the method of data collection and analysis for this research. An extensive literature review was performed to compare the requirements for developing Air Force software user manuals to the requirements for developing Air Force TOs and commercial software user manuals. The resulting data was used to make recommended improvements/changes to current Air Force regulations guiding development of software user manuals.

The next chapter is the literature review, which describes in detail all the regulations guiding the development and acquisition of Air Force software user

manuals and Air Force TOs. This chapter also explores the best commercial practices currently being used by industry to develop user manuals for distribution with computer products, or for internal use by company employees.

III. Literature Review

Introduction

This literature review examines the extent of Air Force policy guiding the development of software user manuals, TOs, and commercial computer manuals, through an analysis of current Air Force acquisition requirements, and best commercial practices. This literature review is intended to answer the following research questions:

1. What are all the regulations guiding the acquisition and development of Air Force software user manuals?
2. How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?
3. How do the requirements for Air Force software user manuals compare to best commercial practices for developing similar manuals?

Because the acquisition of Air Force software user manuals is intricately tied to the development of the software itself, Section 1 provides an overview of the Air Force software acquisition process. Section 2 contrasts Air Force requirements for software manuals with the requirements for Technical Orders. This section is organized into three subsections: Content/Format, Quality Reviews, and Update/Control. Within each subsection is a

discussion of that development area as it pertains to both Air Force software user manuals and Air Force TOs.

Section 3 discusses commercial practices for developing computer user manuals.

Discussion of the Literature

Section 1. The Air Force Software Development Process

Software procurement for the Air Force is required to follow a specific development cycle. The cycle consists of six sequential phases, most of which have an associated review or audit of contractor progress (16:25). The six phases with associated reviews are summarized below:

Software Requirements Analysis- includes evaluating requirements for completeness, understandability, validity, and consistency and...is followed by a Software Specification Review (SSR)...

Preliminary Design Review- includes top-level software design, critical lower-level software design, and...is followed by a Preliminary Design Review (PDR)...

Detailed Design- involves refining the top-level software design to define all information necessary for coding...This step is followed by a Critical Design Review (CDR)...

Coding and Unit Testing- coding translates the detailed design into computer instructions and data definitions.

Computer Software Component (CSC) Integration and Testing- consists of incrementally integrating units and components, and informally testing the result...This integration is followed by a Test Readiness Review (TRR)...

Computer Software Configuration Item (CSCI) Testing- consists of formal tests to verify that each function of the CSCI...satisfies the Software Requirements Specification...This step is followed by a Functional Configuration Audit (FCA).... (16:25-26)

The six phases outlined are described in Air Force Regulation (AFR) 800-14, Lifecycle Management of Computer Resources in Systems. AFR 800-14 discusses the planning, development, acquisition, and support of computer resources in general terms (16:1). More specific guidelines for software development can be found in Department of Defense Standard (DOD-STD) 2167A, Defense System Software Development, which is referenced in AFR 800-14 (16:25). These regulations, and others, will be discussed later in relation to the requirements for software manual development.

Section 2. Requirements for Software User Manuals vs Technical Orders

1. Content/Format.

Software Manual Development. Although AFR 800-14 is supposed to provide general guidance for the development and support of computer resources, only two direct references to documentation exist. The first refers to development and can be found under the heading of "Support Documentation":

Support documentation includes documents related to system management, design, operation, and maintenance. All software support documentation must be delivered in sufficient quality and detail to permit organic government support for the life of the system. (16:11)

The second reference concerns updating documentation:

All documentation (operator/user, maintenance, programmer, training, system/software specifications) will be updated to reflect software changes and be made available concurrent with distribution of updated CSCI products. (16:18)

More specific guidance can be found in DOD-STD-2167A, which is intended to provide specific means for establishing and maintaining quality in the development of Air Force software and its related documentation (9:iii). This standard is important, because it defines and limits the types of software manuals that can be procured, and also delineates the specific requirements for the development of those manuals (9:35).

When a new contract is established, a list is prepared of all the data items the government expects the contractor to deliver. This list is called a Contract Data Requirements List (CDRL). Each type of data item delivered has an associated Data Item Description (DID) which describes the basic format and content requirements for that delivery. DOD-STD 2167A discusses data items related to software development (9:35). Four of the DIDs referenced in this standard define software manuals for Air Force users.

The four DIDs are listed below with short descriptions of their intended use:

Computer System Operator's Manual (CSOM)- provides information and detailed procedures for initiating, operating, monitoring, and shutting down a computer system and for identifying/isolating a malfunctioning component in a computer system. A CSOM is developed for each computer system in which one or more CSCIs execute. (8:1)

Software User's Manual (SUM)- provides user personnel with instructions sufficient to execute one or more related CSCIs. The SUM provides the steps for executing the software, the expected output, and the measures to be taken if error messages appear. The information required by this DID is directed to the functional user of the CSCI, as opposed to the operator of the computer system. (34:1)

Software Programmers Manual (SPM)- provides information needed by a programmer to understand the instruction set architecture of the specified host and target computers. The SPM provides information that may be used to interpret, check out, troubleshoot, or modify existing software on the host and target computers. (33:1)

Firmware Support Manual (FSM)- provides information necessary to load software or data into firmware components of a system. It is equally applicable to read only memory (ROMs), Programmable ROMs, (PROMs), Erasable PROMs (EPROMs), and other firmware devices. The FSM describes the aspects of the firmware devices, support software, support equipment, and the procedures required to load software into firmware devices to verify the load process and to test the firmware device for proper functioning. (20:1)

As mentioned earlier, DIDs contain instructions to the contractor for the basic format and content requirements for the data to be delivered. Each of the manuals listed above requires the same basic format: cover page, title page, a table of contents, scope, referenced documents list, manual specific procedures, notes, and finally appendixes (8:2; 20:2; 33:2; 34:2). The requirements for the manual-

specific procedures are broken down into sections within each DID.

These DIDs, which average 5 pages each, are the only guidance documents that provide specific content requirements for these manuals.

One document was found that specifically addresses software documentation requirements (including those for user manuals). Although titled An Air Force Guide to Software Documentation Requirements, it's an Electronics System Division (ESD) document that was produced by the Mitre Corporation of Bedford Massachusetts (35). The guide discusses documentation used to monitor the software acquisition process as well as documentation intended for use by Air Force personnel, including the Positional Handbook and Computer Users Manual. For each type of document, the following subsections are addressed: Purpose, Uses, Applicability, Relationship to Other Documents, Assessing Adequacy, and Potential Problem Areas. This guide is by far the most detailed document in terms of specifications and procedures for software documentation. Apparently produced in response to an ESD contract for determining or consolidating Air Force requirements for software documentation development, the guide provides the following conclusions:

1. There is no single source of guidance on software documentation...This guidebook may serve as a consolidation of various Air Force sources, summarizing standard data items..

2. There is a lack of guidance on the requirements for, and usage of, documentation related to software and its acquisition.

3. Another general observation is the general lack of detail in the DIDs. Coupled with the lack of guidance on software documentation requirements and the lack of definitions, this situation is unfortunate. (35:133-134)

Technical Order Development. AFR 8-2, Air Force Technical Order System contains official policy on the Air Force Technical Order (TO) system (14:1). The TO-00-5 series of regulations further defines the TO system. TO-00-5-1 gives an overview of the whole Air Force TO system (15), TO-00-5-2 discusses the TO distribution system (17), and TO-00-5-3 provides acquisition procedures for TOs (12).

TO 00-5-1, Air Force Technical Order System, gives a description of the types of TOs in the Air Force (15:2-1). There are five general categories: System and Equipment TOs, Time Compliance TOs, Methods and Procedures TOs, Index Type TOs, and Abbreviated TOs (15:2-7). The actual requirements for the format and content of TOs can be found in numerous military standards. Some of these standards are general nature; others are designed for a specific type of TO, or sections of TOs. A short list of standards is presented next to illustrate the comprehensive nature of the system regulating TO development:

MIL-M-38784B	<u>General Style and Format Requirements</u>
MIL-M-7700C	<u>Flight</u>
MIL-C-38413B	<u>Air Refueling Procedures</u>
MIL-M-38807A	<u>Illustrated Parts Breakdown</u>
MIL-M-38797	<u>Operation and Maintenance Instructions</u>
MIL-M-26788C	<u>Operation and Maintenance Instructions (Vehicles)</u>
MIL-C-9927A	<u>Operational and Organizational Maintenance Checklists</u>
MIL-M-38793	<u>Calibration Procedures</u>
MIL-M-38795B	<u>System Peculiar Corrosion Control</u> (13:29-32)

The development of any one TO will often require multiple standards. In addition to all the standards, general policy dictates that all newly developed TOs must be written to a 9th grade reading level (13:5).

Software manuals are not mentioned under any of the TO category descriptions in TO 00-5-1 (15:2-1-2-6) and there are no standards dedicated to their development (12).

2. Quality Reviews

Software Manuals. Military Standard (MIL-STD) 1521B, Technical Reviews and Audits for Systems, Equipments, and Computer Software, discusses the procedures to be followed during the reviews and audits of contractor progress which were briefly mentioned earlier (11:19-123). This standard is organized by review and contains specific instructions on what material is to be presented for review,

and, in some cases, the criteria for review (11:19-123). The first time software manuals are specifically referenced is under the procedures section for the Critical Design Review (CDR) which occurs toward the end of the system development cycle (11:56). They are listed, along with multiple other items, under a heading which reads: "The contractor shall present the following for review by the contracting agency:" (11:54). No criteria for evaluating the manuals is provided. Software manuals are not mentioned again until the procedures for the Physical Configuration Audit (PCA) are discussed (11:82). The instructions provided read:

As a minimum, the following actions shall be performed by the PCA team on each CSCI being audited:...Check Software User's Manual(s), Software Programmer's Manual, Computer System Operator's Manual, Firmware Support Manual... for format completeness and conformance with applicable data item descriptions. (Formal verification/acceptance of these manuals should be withheld until system testing to ensure that the procedural contents are correct). (11:82)

MIL-STD 1521B isn't the only document which addresses software review, or quality issues. Military Specification (MIL-S) 52779A, Software Quality Assurance Program Requirements, mandates the establishment of a quality assurance program, and associated plan, to ensure new software complies with contract requirements (10:1). None of the four software manuals discussed earlier are specifically mentioned. There is, however, a requirement to include in the quality assurance plan the procedures which

will be used to assure software documentation complies with contractually required standards (10:3). No recommendations are made as to what types of procedures are appropriate. It is apparently left to the discretion of the specific Air Force acquisition agency to determine the type and extent of procedures to be imposed on the contractor.

Technical Orders (10). TO 00-5-3, Air Force Technical Manual Acquisition Procedures, outlines all the steps required for TO development through each stage of program acquisition. The process involves a conference dedicated to TO development, multiple reviews to monitor contractor progress, a validation of the manuals by the contractor, and a verification process performed by the Air Force. Specific procedures and review criteria are presented for each step of the process. In addition, there are a number of required planning documents (both Air Force and contractor developed), which outline the TO acquisition strategy.

Software manuals are not mentioned in the descriptions of this review cycle.

3. Update/Control. (18)

Software Manuals. Air Force Technical Order 00-5-16, Computer Program Identification Numbering (CPIN) System, Software Managers Manual, describes the CPIN system and provides guidance on its use. The CPIN system is a new effort in the Air Force to treat computer programs as

configuration items. Each CPCI will be assigned a CPIN number for distribution and tracking within the Air Force system. Instructions for the control of software manuals are described as follows:

USER DOCUMENTATION. User documentation includes users manuals, test equipment manuals, and user maintenance manuals which are required by the user for operational use, checkout, installation, troubleshooting, and loading of the CPCI. User documentation will not be assigned a CPIN but will be assigned an appropriate technical order number and will be managed by the Technical Order System as applicable. User documentation will reference the applicable CPCI by the appropriate CPIN. (18:3-2)

Technical Orders. TOs are distributed and controlled according to the policies and procedures of TO 00-5-2, Technical Order Distribution System (17). The Air Force TO distribution system is managed by Oklahoma City Air Logistics Center (OC-ALC) (14:2-1), the same base that manages the CPIN system discussed earlier (18:1-1).

Section 3. Commercial Practices for Developing Software Manuals

"When the discussion turns to commercial software, one usually hears compliments for what the software does but criticisms for its documentation" (27:355). One of the reasons for the above is that currently there is no accepted, documented standard for producing software user manuals. There is an organization designed to establish standards for all varieties of commercial practices, the American National Standards Institute (ANSI). A 1988

article from the Journal of Technical Writing and Communication states:

Such a documentation framework will result primarily from the efforts of the technical committees of the various standards organizations. For example, the ANSI Accredited Standards Technical Committee (X3K1) on Project Documentation is attempting to develop a standard for user documentation of any type of software product designed to be sold commercially. (27:357)

As of this writing, however, no such standard exists for developing software user manuals (7). This lack of specific guidance is often quoted as a serious problem in manual development (27:356), and many companies have begun producing their own self imposed standards (25; 28; 32).

The absence of specific, industry wide procedures makes it difficult to define "best commercial practices." The information that follows then, is the recommendations and views of various companies or private sources regarding their ideas of what constitutes best practices for developing software user manuals.

It is generally agreed that quality user manuals are essential for promoting the sale of a software product. "If a company's publications do not work well, then its customers may never find out how really well the product works" (1:68). Although this fact would seem obvious enough, attention to the importance of quality software documentation is a fairly recent trend (27:355). Historically, software documentation was often poorly organized, incomplete, and badly written (27:355). One

software maintainer was quoted in a Computerworld article as saying: "I'm going to assume this is typical maintenance documentation - not worth the paper it's printed on" (21:90).

Besides the lack of accepted standards, there are a number of other factors which can contribute to poorly developed documentation. One area of potential problems is assigning the documentation process to the wrong people. The development of the software feeds into the documentation development; it's important that technical writers understand the logic and functioning of the software, but they also need good writing skills to transfer that understanding to new users (1:66). A skilled software engineer doesn't necessarily make a good technical writer, and a good writer can't write effectively about processes he doesn't understand.

Just as an engineer must understand material properties...a competent technical writer should understand how to use rhetorical devices to achieve the most elegant and proper solutions. Understanding grammar, its uses and structures, is basic to all good writing. Since most technical writers are learning with each new assignment, there's no time to be learning the basics, too. (1:66)

Ensuring good documentation then, begins with providing people who have the right skills for the job. Recognition of this fact has increased emphasis on technical writing as a respected profession, and is increasing the availability of skilled writers.

Writing software documentation, which often has been relegated to programmers as an afterthought, is getting some recognition as a field in its own right. In recent years, many universities and colleges have introduced technical writing programs. (23:106)

Another crucial ingredient for producing quality manuals is management support. "Executives must be convinced that professional publications are significant to the quality of the company's image" (1:63). Without emphasis and support from upper management, the necessary resources (people, time, money) won't be devoted to the project, and quality will suffer.

Having determined the right people for developing the software documentation, and securing management support, the first step, prior to actual development, is to perform a requirements analysis (4:362). A requirements analysis is the starting point for determining the type of information that will be included in the manual, as well as the design of the final document; essentially a plan of attack for the whole development effort, it is extremely important for producing user-centered documentation. In its most basic form, a requirements analysis includes a determination of the types of documents the user will require (Reference Manuals, Users Guides, Operations Manuals) (32), task analysis: the tasks required of the users (22), the media of presentation (printed vs online) (4:362), as well as audience analysis: the skill level of the intended users. Within the requirements analysis, the two most involved and

critical areas to document success are task analysis and audience analysis.

Task analysis is the phase where the system orientation of the software is translated into the user orientation required for the documentation. Task analysis should answer the following types of questions:

Who performs the task?

What actions begin each task?

What are the specific steps involved in performing the task?

What actions end each task?

Are there any variations in hardware or in the general environment in which the task takes place that would alter it? (6:MG-55)

Audience analysis is a special area of concern because of its applicability to all types of user manual development. Audience analysis includes: determining the end user's skills (expertise with computer operations, educational level and corresponding reading level), motivation for using the software (objective, goals), and frequency of use (intend to increase skills vs infrequent reference) (6:MG-56). "Audience analysis will have a major impact on both system and document design" (4:364).

During the actual development of software manuals, there are two main concerns: design (or format) of the manuals, and the usability of the document. Quality software documentation will be designed with the user in mind, and based on the results of the requirements analysis.

Although specific design considerations will be a result of the type of manual produced, some general distinctions can be made between traditional, product-centered documents and the more recent, user-centered documents in terms of design (2). Tables 1 and 2 contrast the two approaches.

Table 1. Characteristics of Product Centered Documentation (2:WE-45)

Characteristic	Expression
Organization of Books and Chapters	The users have similar tasks to perform and technical backgrounds: therefore, product determines organization.
Number of Pages in the Documentation	High page counts are common. White space is rare.
Headings and Labels	Headings are based on what the product does.
Size of Units of Information	A single unit may be three or pages in length.
Use of Devices for Quick Access	Charts, when provided, include information on several issues.
Design of Steps in A Procedure	Procedures consist of any number of steps. User actions and the response of software are numbered.

User-centered documentation is task oriented, and has been gaining popularity for writing software manuals. Studies about the benefits of task oriented procedures have concluded that "task oriented, step-by-step information is essential when users are unfamiliar with the projects" (26:362). Task oriented information appears to increase

overall productivity for the user, while decreasing error rate and the level of dissatisfaction with the product (26).

Table 2. Characteristics of User Centered Documentation (2:WE-45)

Characteristic	Expression
Organization of Books and Chapters	The users have different tasks to perform and technical backgrounds: therefore, the users' tasks determine organization.
Number of Pages in the Documentation	Writers attempt to use charts to minimize page count and to provide white space.
Headings and Labels	Labels are based on what the user does.
Size of Units of Information	Information is broken into small units, each under one page in length.
Use of Devices for Quick Access	Charts are a commonly used device. Charts contain only information relevant to the user's immediate action.
Design of Steps in A Procedure	Procedures are subdivided so that each subprocedure consists of under seven steps. Only user actions are numbered.

Usability seems to be an all encompassing term; generally referring to how easily the user is able to access and understand the information presented in the document (36:120). Factors affecting usability are numerous; some examples include: sentence structure, grammar and punctuation, tone, voice, tense, word choice (difficulty vs accuracy), logical organization, relevance, sequence, and balance (29). The correct application for some of these

factors, such as word choice, sequence, voice, and tone, is determined by the characteristics of the user and should be obtainable from the results of the audience analysis. The other factors are determined by the author's writing and grammar skills; providing skilled technical writers will help decrease usability problems.

Another area of vital concern, and potential problems, is performing quality reviews of the manual. One of the greatest potential problems involved with quality reviews is the time required to perform them. Depending on the extent of the review cycle planned, as well as the size of the documents being produced, the cycle can consume a good deal of the development schedule. The reviews require not only the writer's time, but also contributions from the developers, quality assurance personnel, and possibly the users. The amount of cooperation required with so many participants can also create a great deal of conflict and personnel problems.

At all companies, the politics of documentation can become especially heated during review cycles, when publication drafts must be critiqued by developers, marketing staff, customer service personnel, quality controllers, and lawyers, any or all of whom won't agree with parts of the publication or with each other and few of whom will acknowledge limits to their critical ability. (1:68)

This potential conflict and the required assurance of sufficient time for performing quality reviews, highlights the importance of management support and a team approach to

the review cycle in order to assure the ultimate success of the documentation process.

The review of the documentation usually gets put at the bottom of the programmer's priority list. Many weeks past the requested date, the writer will finally receive the corrected drafts.

The most egregious cause for delay occurs when management has budgeted no time for the review of documentation.

The second most flagrant cause of delay occurs when management has budgeted the time for reviewing documentation, but uses the time for programming because the project is behind schedule. (30:26)

Besides management support, another important consideration for ensuring the success of the documentation review process is the use of a publication plan for organizing and controlling the whole document development process. This publication plan can help eliminate scheduling problems and increase cooperation among the involved departments.

The publications plan is used to describe the publications that will be produced for the specified product. The description should include an annotated list of the publications to be written, what dependencies govern their production, an outline (as detailed as possible) of each publication, and a schedule for their development. The publications plan also should include schedules for each version of each manual, including dates of distribution for review, review meetings, the final date to submit comments and changes to the writer, and the date each version will be finished, to the printer, and ready to ship. (31:WE-148)

The depth of quality reviews can vary greatly depending on the philosophy of the company, and the intent of the documentation; they range from in-house reviews of the final product to user input throughout the development process, with usability testing before publication.

In-house inspection of draft manuals is the traditional, most widely practiced form of quality reviews, and is critical to ensure the accuracy of the documentation. During an inspection, the technical accuracy of the documentation is checked by comparison with the software code, and any defects noted for correction. If performed early in the development process, this inspection can drastically reduce costs. Given a cost of \$X dollars to correct errors during development, it will cost ten times that amount (\$10X) to correct the deficiencies at the quality review stage, and one hundred times that amount (\$100X) if corrected after the document has been published (3:WE-52).

Recent emphasis on more user centered documentation is increasing the popularity of including usability testing in the development of documentation.

In its strictest sense, usability testing is the analysis of a product to determine how useful it is to its targeted customer...the testing of a document by a user to determine if that document meets the needs of that user. (6:WE-154)

There are several ways to conduct usability testing, among which are:

- * Silent User
Video tape the customers as they use the documentation.
- * Structured Interview
Sit with the customers as they use the documentation and ask them questions.
- * Verbal Protocol
Ask the customer to think aloud as they use the documentation while video and audio taping them.

- * Verbal Protocol After Talk
Ask the customer questions about the documentation after they have used it.
- * Validation Laboratory
Have an agreement with a university to provide space and participants to test the documentation; video and audio tape the tests. (5:MG-58)

Some of the issues associated with usability testing include schedule/time constraints, added costs, locating suitable reviewers to use the documentation, acceptable ranges of usability scores, measurement mechanisms, and audit trails (5:WE-151). When determining the extent of quality review that should be performed for a set of documentation, these issues, along with their associated costs, should be weighed against the potential benefits of usability testing.

Usability testing...does the following:

- * Validates or invalidates the data gathered during audience analysis
- * Validates or invalidates the content as well as the design paradigm of the review draft
- * Allows the customer to input directly to the document and perhaps to improve the design
- * Provides a mechanism for assessing the audience feedback and for maintaining the currency of the documentation
- * Gives invaluable insight into user psychology
- * Allows measurement not only of how customers use the documentation, but at what level of effort
- * Supplies a tool to measure precisely where the document succeeds and where it fails (5:MG-57)

Without regard for cost, the most stringent and effective (in terms of accuracy) document review cycle would be the one pictured in Figure 1.

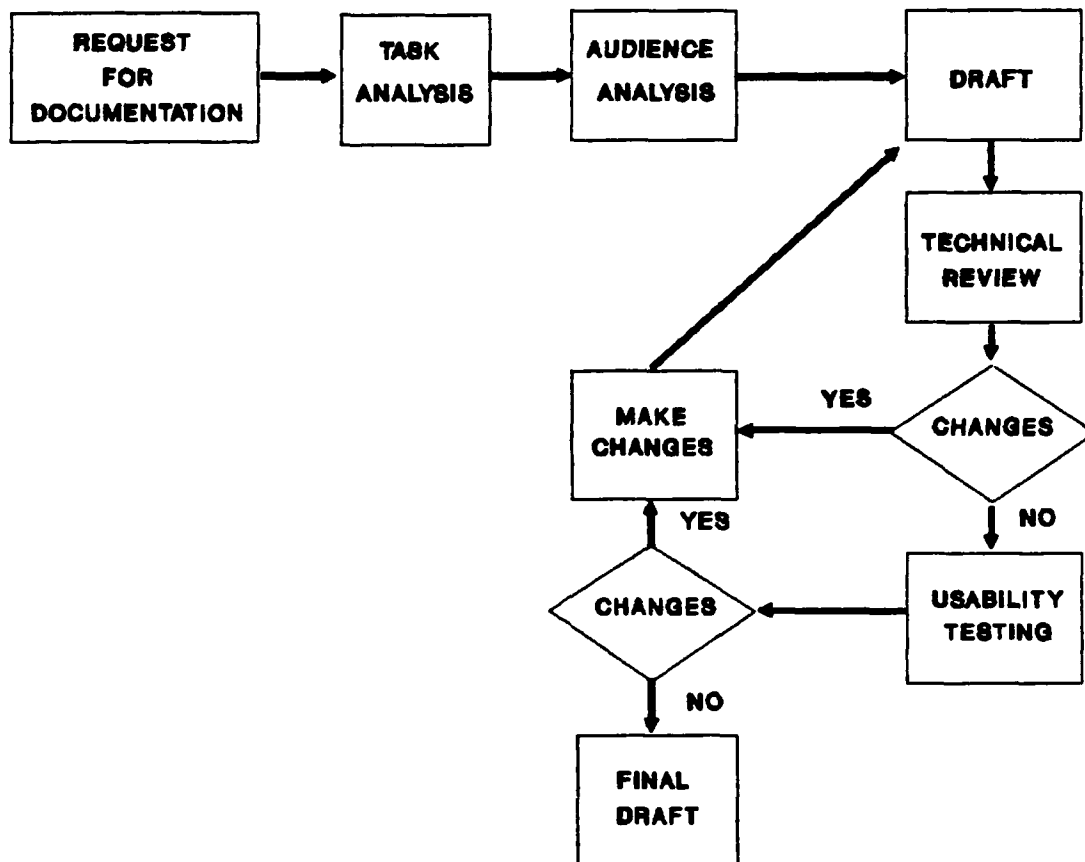


Figure 1. Documentation Review Cycle

The last issue of software documentation that will be discussed is the updating, or maintenance process for documentation. As compared to the other issues discussed so far, this topic is the least discussed in the literature; very little information is available on the details of how the commercial industry treats this aspect of software documentation.

Software documentation maintenance is a myth that everyone believes in but almost no one ever does...only a handful of corporations ever do a decent job of chronicling changes, updates, and improvements to their code. (21:87)

One particular article was found that very thoroughly addressed the issue of documentation maintenance. The key element identified was the idea of planning the maintenance process before publication. This planning involves creating a schedule of maintenance activities and the production of a Maintenance Guide by the developer (23). "The Maintenance Guide is a valuable tool that provides all of the information you need to maintain the document" (23:WE-135). The important elements of the guide include: a description of the background information for the document, the strategy and requirements for maintenance, the location of materials used to produce the documentation, the hardware and software used to produce the documentation, style guidelines of the document, the production process used, a distribution list of all recipients, and a record of maintenance actions (23). This Maintenance Guide could be a valuable tool for organizing and controlling the maintenance process for software documentation.

Summary

This chapter has summarized an extensive literature review which compares the requirements for developing Air Force software user manuals to the requirements for developing Air Force TOs and commercial software user manuals. Section 1 of this chapter briefly discussed the Air Force software acquisition process, and was intended to serve as an overview to provide better understanding of the

software manual acquisition process, presented later in this chapter. Section 2 of this chapter contrasted the requirements for Air Force software manuals to the requirements for Air Force TOs in three general areas: Content/Format, Quality Reviews, and Update/Control. The final portion of the chapter, Section 3, presented a wide variety of ideas and recommendations on the various factors influencing software manual development within private industry.

The next chapter, Chapter IV, will analyze the results of the literature review presented in Chapter III to answer the following research questions:

1. What are all the regulations guiding the acquisition and development of Air Force software user manuals?
2. How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?
3. How do the requirements for Air Force software user manuals compare to best commercial practices for developing similar manuals?

IV. Findings

Introduction

This chapter will analyze the results of the information presented in the Literature Review of Chapter III, to answer the following research questions:

1. What are all the regulations guiding the acquisition and development of Air Force software user manuals?
2. How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?
3. How do the requirements for Air Force software user manuals compare to best commercial practices for developing similar manuals?

Findings For Research

Research Question #1: What are all the regulations guiding the acquisition and development of Air Force software user manuals?

There are very few regulations guiding the development of Air Force software manuals. AFR 800-14, Lifecycle Management of Computer Resources in Systems, indirectly affects software manual development by providing general guidance on the development of the software to which it pertains. The regulation only provides two direct requirements for software documentation: that it be

sufficiently detailed to permit organic support, and that documentation is updated to reflect software changes as the change is released (16).

DOD-STD-2167A, Defense System Software Development, addresses software manuals more directly by delineating the types of manuals that can be procured and listing the respective number of the Data Item Description (DID) which describes its purpose and format (9). There are only four user type manuals listed in DOD-STD-2167A: Computer System Operator's Manual, Software User's Manual, Software Programmer's Manual, and the Firmware Support Manual (9). There is a five page DID associated with each manual. Each DID has the same basic format: cover page, title page, table of contents, scope, manual-specific procedures, and appendices; only the "manual-specific procedures" section differs from DID to DID (8; 20; 33; 34).

In summary, the two regulations discussed above, AFR 800-14, and DOD-STD-2167A, along with the five DIDs, are the only documents guiding the content of software user manuals.

Requirements for quality reviews are even less stringent than those for content. MIL-STD-1521B, Technical Reviews and Audits for Systems, Equipments, and Computer Software, references software user manuals twice. The first reference requires that the manuals be reviewed at the Critical Design Review (CDR) for software development, but no evaluation criteria are provided for use in evaluating

the manual (11). Are the manuals to be checked against the software, or against the requirements of the DID? Who in the Air Force should be reviewing the manuals: users, program office personnel, or engineers? No specific guidance on these issues is provided. The second reference is a little more substantial, requiring review of the manuals during the Physical Configuration Audit (PCA) to ensure "format completeness and conformance with applicable data item descriptions" (11:82).

In addition to MIL-STD-1521B, MIL-S-52779A, Software Quality Assurance Program Requirements, is concerned with quality assurance of software and its related issues (10). MIL-S-52779A mandates a quality assurance program, and associated plan to ensure compliance of the delivered software products with the specified requirements of the contract. Although the four user manuals mentioned in DOD-STD-2167A aren't specifically referenced, there is a requirement to include software documentation review procedures in the quality assurance plan prepared by the acquisition agency (10:3). Once again, no procedures are provided, nor any recommendations as to where to locate appropriate procedures or review criteria. It's apparently up to the Air Force acquisition personnel to use the contract requirements to set their own procedures and corresponding stringency measures when reviewing these manuals.

The area of update and control for software manuals is no better. Although the software systems they support are well controlled, the requirements for the user manuals are very confusing. Software programs are now managed under Air Force Technical Order TO-00-5-16, Computer Program Identification Numbering (CPIN) System, Software Managers Manual, which assigns identification numbers to the software for distribution and tracking (18). The requirements for the user manuals are stated as follows:

USER DOCUMENTATION. User documentation...will not be assigned a CPIN but will be assigned an appropriate technical order number and will be managed by the Technical Order System as applicable. User documentation will reference the applicable CPCI by the appropriate CPIN. (18:3-2)

The above statement seems to have been thrown in to compensate for the lack of direction for controlling software user manuals. It is apparent it wasn't an organized effort to improve the deficiencies, since the term "as applicable" has no reference as to what portions of the Technical Order System are in fact, applicable. There are no specific references within the TO regulations to user manuals; nor are there any references within the software regulations to the use of TO regulations for software documentation.

In summary, the regulations guiding quality requirements, or update and control of software user manuals are dispersed, unclear, and disorganized. This fact was recognized many years ago in a document produced for

Electronics System Division through a contract with Mitre Corporation of Massachusetts. The document, titled, An Air Force Guide to Software Documentation Requirements, attempted to consolidate and clarify the exact requirements for procuring software user documentation (35). Dated 1976, the document provided these conclusions (amongst others):

1. There is no single source of guidance on software documentation...This guidebook may serve as a consolidation of various Air Force sources, summarizing standard data items..

2. There is a lack of guidance on the requirements for, and usage of, documentation related to software and its acquisition.

3. Another general observation is the general lack of detail in the DIDs. Coupled with the lack of guidance on software documentation requirements and the lack of definitions, this situation is unfortunate. (35:133-134)

Although its stated purpose was to act as a "guidebook" for consolidating software documentation requirements, no references to it were ever found in any of the regulations. Although no longer applicable because many of the regulations and all of the DIDs have been revised since its writing, the problems it reported still exist today. Obviously, the conclusions it provided went unheeded since all of the regulations discussed in this paper, which guide development of software manuals, were written after 1979, three years after the paper was produced.

Research Question #2: How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?

In each of the areas reviewed: content, quality review, and control, the regulations guiding TO development are much more extensive and better organized than the regulations for software user manuals. The requirements for TO development are primarily consolidated in the TO-00-5 series of regulations, with individual military standards dedicated to almost every type of TO developed for the Air Force. There is a set quality review policy for all TOs, which requires reviews throughout development, as well as a validation (contractor checks TO against equipment) and verification (user testing for accuracy and readability). Specific review criteria and controls are established for each step of this review process. There is also a standard document for inclusion on all contracts requiring TO development; Technical Manual Contract Requirements 86-01 aids the acquisition agency in ensuring all needed standards are included in the contract (13). In addition, all TOs are required to be written to a 9th grade reading level.

Distribution and control of TOs is also well organized and well documented; TO-00-5-2 lays out all requirements and procedures for numbering, distributing, and updating TOs. The whole TO system is an antithesis of the scattered regulations guiding software user manual development.

Research Question #3: How do the requirements for Air Force software user manuals compare to best commercial practices for developing similar manuals?

The commercial industry faces the same problem as the Air Force when it comes to developing software user manuals: there is no single standard or reference guiding their development. Unlike acquisition agencies within the Air Force, however, private companies have the ability to institute new procedures as they see fit, to improve the quality of their products.

There's an almost limitless amount of literature available, documenting every aspect of computer manual development. Information on suggested content and format can be extremely detailed, and is often specific to the type of manual being produced. Although the degree of quality reviews required varies from company to company, there is a growing trend in the literature supporting usability testing before publication. This usability testing is similar to the verification procedure required for Air Force TOs. The area of updating and controlling software user manuals once they're published has received the least attention, but good source information is available.

The literature available on different procedures used by the commercial industry demonstrates that many companies are imposing much more detailed and stringent requirements on the development of their software user manuals, than the

Air Force currently imposes on the development of software user manuals for its own use.

In general, commercially produced software user manuals have been improving over the last decade. The recognition of technical writers as a respected profession, the increased competition within the computer industry, and an increased awareness and publication of prior deficiencies with user manuals, have all contributed to improvements in development practices. An added boon is that companies are sharing their experiences and publishing articles that detail development procedures. All the information needed to set up a quality software development effort is available, waiting to be consolidated.

Summary

This chapter used information presented in the Literature Review of Chapter III to answer the following research questions:

1. What are all the regulations guiding the acquisition and development of Air Force software user manuals?
2. How do the requirements for Air Force software user manuals compare to the requirements for Air Force Technical Orders?
3. How do the requirements for Air Force software user manuals compare to best commercial practices for developing similar manuals?

The findings indicate that the requirements for Air Force software user manuals are dispersed, unclear, and non-specific. The requirements for Air Force Technical Orders on the other hand, are consolidated, well organized, and extremely detailed. Although the requirements for developing and producing software user manuals in the commercial industry can vary from company to company, there are many detailed, well documented procedures available for producing quality manuals.

The next chapter will also use the results of the Literature Review of Chapter III to answer the last research question:

4. What improvements, if any, can be made to the current Air Force regulations guiding software user manual acquisition?

In addition, recommendations for further research on this issue, as well as related topic areas affecting software manual development, will be presented.

Chapter V. Conclusions and Recommendations

Introduction

This chapter will summarize the results of the literature review to answer the last research question:

4. What improvements, if any, can be made to the current Air Force regulations guiding software user manual acquisition?

Recommendations will also be made regarding areas for further research, and related topic areas.

Conclusions

The literature review presented in Chapter III clearly shows the need for improvements in the acquisition requirements for Air Force software manuals. The requirements for software user manuals desperately need consolidation! The option which first comes to mind is the idea of including software user manuals in the TO requirements system. The TO system is centralized, well organized, and highly specific; an excellent example of quality documentation standards. Including software manuals in this well structured system could have distinct advantages. The requirements for TOs are primarily found in the TO-00-5 series of regulations which are well established and familiar to most acquisition organizations; including software manuals in this series of regulations would provide a localized, and well recognized, source of standards. The

requirements for the controlling and updating of software and its related documentation is already included in TO-00-5-16, US Air Force Computer Program Identification Numbering System. In addition to localizing the requirements, there are many techniques used for developing TOs that could be applied to software user manuals. For example, the requirements for validating (contractor checks TO against system) and verifying (user testing for accuracy and readability) TOs would provide an excellent quality assurance program if applied to software user manual development. The requirement for standardizing the reading grade level of TOs could also be applied to software user manuals. Probably the greatest disadvantage, however, is the problem of adding to an already burdened system of regulations. Because the requirements for all the various types of TOs are so exacting, the regulations for their development and control are quite extensive. Adding software user manual requirements to these established standards runs two risks: the requirements for software manuals will become so dispersed throughout the regulations that the benefits of centralization will be lost, and that unique requirements for software manuals may be overlooked when fit into the TO regulation structure.

A better suggestion is to create a separate set of regulations which are specific for software manuals. The need for centralization would be fulfilled, and the resulting standards would potentially be much better

organized and more easily referenced than a huge series of combined regulations. This would simplify the job of Air Force personnel responsible for contracting and administering the acquisition of these software user manuals, helping to eliminate mistakes or oversights and contributing to better quality products. This doesn't mean the valuable techniques and lessons presented in the TO system of regulations should be overlooked. There are many areas of dual applicability that could be included in the separate set of standards. The very fact of their separation would increase flexibility for modifying TO requirements if necessary, to meet specific needs of software user manuals. The system for developing Air Force TOs has evolved and improved over many years, and should serve as a first template for organizing and developing a set of unique standards for software manual acquisition.

The quality of the documentation will only be as good as the intrinsic quality implied by the standard. An ambiguous or weak standard will result in documentation of dubious quality. (22:WE-52)

It's also important to consider the techniques currently being used by private industry for developing software manuals. The incentives for profit and customer satisfaction have led to great improvements in the quality of software documentation being produced in the commercial sector. The Air Force would do well to capitalize on those improvements by imposing requirements on their contractors which parallel or duplicate some of the better techniques

currently in use in private industry. For example, the Air Force could require their contractors to hire trained technical writers, document their system of internal reviews, or present a schedule of development for successive drafts and their corresponding reviews. A publications plan prepared by the contractor and submitted to the Air Force for review could incorporate all of the above issues; the standards for a Technical Manual Publications Plan (TMPP) and a Technical Manual Status and Schedule (TMSS) already exist, and are required for the acquisition of Air Force TOs. The requirement for a Maintenance Plan similar to the one discussed in Chapter III would also be highly desirable; one of the enduring facts of life is that software is always modified, and it's important that the documentation to support that software be updated accordingly.

Recommendations for Further Research

In attempting to narrow the focus of this research and maintain a concise, logical flow of information, many issues related to the acquisition and development of software user manuals were excluded. Perhaps one of the better known issues is the use of electronic publishing for producing documentation. This topic has received a great deal of attention in the commercial literature, and is definitely a technique that is gaining popularity. The benefits that electronic publishing could have on the organization and potential usability of software manuals were beyond the

scope of this research, but deserve to be evaluated. Such an evaluation could provide the Air Force with valuable information for developing future acquisition strategies for software user manuals.

In developing a new set of standards for software user manuals, it is strongly suggested that inputs from the acquisition personnel who will use the regulations, as well as the end users of the manuals, be gathered to determine perceived shortfalls for the system. Air Force users are analogous to customers in the private sector; whether trying to turn a profit, or increase the performance of the organization (as is the case in the Air Force), customer satisfaction is the key. A study surveying acquisition personnel and users within the various commands would be invaluable for ensuring a comprehensive set of standards.

This research has examined computer user manuals in general terms, including operating manuals and maintenance manuals in the same group, because the Air Force doesn't provide separate requirements for each. Another aspect of developing standards for computer user manuals is to clearly define the requirements for both types of user documentation; many times, only minor aspects of software maintenance are allowed because it's assumed that Air Force maintenance personnel don't have the expertise to perform any detailed maintenance actions. When it comes to modifying or rewriting lines of code, the assumption is probably correct; however, there may be many other aspects

of software maintenance that could be performed by Air Force personnel. Considering the huge costs associated with software modifications, it would be a good idea to establish realistic limits on the amount of software maintenance that can be performed by Air Force personnel, and impose those limits Air Force wide.

In performing the research to develop the literature review of Chapter III, many articles were reviewed and determined to contain information related to, but not directly relevant to, the aspects of the problem chosen for discussion. Appendix A has been included to provide the reader with some additional sources related to the subject of this research, but not cited in the bibliography. This list is not meant to be comprehensive; the area of commercial literature is so extensive, in fact, that Appendix A is only a hint at the amount of information available regarding computer manual issues.

Summary

This chapter has used the information presented in the literature review of Chapter III to answer the final research question:

4. What improvements, if any, can be made to the current Air Force regulations guiding software user manual acquisition?

Based on the results of the literature review, it's clear that there is generous room for improvement in the

system of regulations guiding Air Force software user manual acquisition. Two possible solutions are immediately apparent: combine the requirements for software user manuals with those for technical orders or develop a separate set of standards for the software user manuals. In examining some of the advantages and disadvantages of each solution, a recommendation for a separate set of regulations is the preferred choice.

Conclusion

This thesis has examined in detail, the regulations guiding the development and acquisition of Air Force software user manuals. It has also compared those regulations to the requirements for developing Air Force Technical Orders, and the techniques used by private industry for developing similar software manuals. Based on the results of this research, it is recommended that the Air Force revise and consolidate the regulations for developing software manuals, using the Technical Order system as a template.

Appendix A: Related Information Sources

Military Sources

AFR 700 regulation series, Communications-Computer Systems.

Bausman, Karen B., Computer Program Documentation-What is Overkill?. Wright-Patterson AFB OH (AD-P000198).

Crawford, Major Nettle L., and Capt Edward R. Dawson, Avionics Intermediate Shop Software. Air Force Logistics Management Center, Gunter AFB AL, July 1989 (Report LM870733) (AD-B135340).

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Commercial Sources

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Vita

Captain Amy Baines was born Amy M. Connolly, on 29 January 1961 in Lackawanna, New York. She graduated from Lackawanna Senior High School in June 1979 and attended Buffalo State College for one year before transferring to the University of South Florida in Tampa, where she received a Bachelor of Arts degree in Zoology, in 1983. Captain Baines joined the Air Force in July 1986, attended Officer Training School, and was commissioned on 24 October 1986. She served her first tour of duty at Wright-Patterson AFB, Ohio, assigned to the Acquisition Logistics Division of Air Force Logistics Command (AFLC). She was co-located into the Reconnaissance and Electronic Warfare Directorate of Aeronautical Systems Division (ASD), where she worked as an Integrated Logistics Support Manager (ILSM) for development of the TR-1 Ground Station. In February of 1989, she was chosen to act as the Deputy Program Manager for Logistics (DPML) for the TR-1 Program, and remained in that position until entering the School of Systems and Logistics, Air Force Institute of Technology, in May 1990.

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